

XX. *Notes on Brazilian Entomology.* By Dr. FRITZ MÜLLER.

[Read June 5th, 1878.]

*Odours emitted by Butterflies and Moths.*

Two years ago I ventured to suggest\* that all those various pencils, tufts or manes of hairs, all those chalky, silky or velvety spots of peculiar scales, as well as the recurved margins or other pouches enclosing pale buff or white down, which distinguish the wings of the male sex in many butterflies, might be odoriferous organs. This suggestion might then have been justly censured as too rash, being founded on the actual observation of odours in four species only, and I felt, of course, the necessity of testing this view by examining as to their odours all living butterflies I might be able to procure. I will here give the results hitherto obtained, enumerating those species† in which distinct odours could be perceived, and I hope the facts to be given will fully justify my suggestion.

Odours, as well as colours, may have been acquired by butterflies either for protection or as an attraction between the sexes. Protective odours appear to be in most cases equally strong in both sexes, or sometimes stronger in the females; they may exist in the caterpillar as well as in the perfect insect. When capable of voluntary emission, they are emitted as soon as the animal fears some danger, *e. g.*, when it is seized, and this may in some cases serve to distinguish them from sexual odours.

Sexual odours may be divided into two classes.

Firstly, those which give notice to the opposite sex of the existence of, and lead it the way to, the odoriferous animal. Such odours must exist in many female moths which attract the males from great distances. Among butterflies the males appear to be guided more by the colour than by the odour of their females.

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\* *Jenaische Zeitschrift für Naturwissenschaft*, xi. p. 99.

† I am much indebted for the names of the butterflies mentioned in this paper to Prof. A. Gerstaecker and Dr. O. Standinger.

Secondly, those odours which do not serve as a guide, but as an excitement to the opposite sex. They appear to be by far more frequent in the males, though occurring also in some females. Odours of both classes will of course be agreeable to the attracted or allured sex: but in the first class the odour of the female is agreeable to the male because it is the odour of his female; while in the second class the odour emitted by the male is agreeable to the female, males with that peculiar odour having been preferred. The two classes may, of course, graduate into each other.

Colours, whether acquired as an attraction by the males or for the sake of protection by the females, are often transmitted to the opposite sex; with sexual odours of butterflies this seems but very seldom to be the case.

I shall not enter into minute descriptions of the odoriferous organs,\* nor mention those very numerous species, which, though evidently possessing such organs, emit odours too faint for human noses; the only object of this paper being to state that there are a large number of male butterflies provided with special organs for the production and emission of peculiar odours.

## BUTTERFLIES.

### Family 1. NYMPHALIDÆ.

#### Subfamily 1. DANAINÆ.

##### A. *Danaïs* group.

*Danaïs Erippus*, *Danaïs Gilippus*,† *Lycorea* [sp.?] and *Ituna Ilione* have a pair of finger-like hollow processes at the end of the abdomen, into which they can be retracted; they bear a tuft of black hairs, radiating in every direction and emitting a rather disagreeable odour, when the processes are fully protruded. This odour is extremely strong in *Lycorea* and *Ituna*, less so in *D. Gilippus*, and rather faint in *D. Erippus*, differences exactly

\* A series of papers describing odoriferous organs of various butterflies and moths have been sent for publication to the "Archivos do Museu Nacional do Rio de Janeiro."

† *Kirby* (Synon. Catal. of Diurn. Lepid. 1871, p. 7) doubts whether *D. Gilippus* may not be a variety of *D. Erippus*. But the caterpillars are quite different; those of *Erippus* have two, those of *Gilippus* three, pairs of "tentacles." The microscopical structure of the "sexual spot" of the male also shows considerable differences.

corresponding to the different sizes of the tufts in the several species. The male of *Ituna* sometimes protrudes his tufts, when he is seized, so that in this butterfly the odour may serve both to repel enemies and to allure females. The well-known "sexual spots," or rather pouches, on the first median nervure of the hind wings of *D. Eriippus* and *Gilippus*, which are much larger in this latter species, appear to be, by their microscopical structure, scent-producing organs; but as they open only by a narrow slit, odours could hardly be freely emitted. There is one curious circumstance, which may perhaps throw some light on their as yet very doubtful function; the scales, though perfectly preserved everywhere else, are often wanting at the entrance of the pouch, as if they had been scoured away by something introduced into the slit. It would be worth while to see whether this be the case with other species of *Danaüs* also. Might not the tufts be introduced into the pouches to be impregnated there with odoriferous matter?

#### B. *Ithomia* group.

The males have a tuft or pencil of long hairs near the anterior margin of the hind wings,\* which in all our species emits a more or less distinct odour. The odour is rather strong and most agreeable, resembling vanilla, in *Dircenna Xantho*, rather faint in *Ceratinia Eupompe* and *Ithomia Sylvo*; it is still more so in *Mechanitis Lysimnia*, where I perceived it distinctly in but few males. In *Thyridia Megisto* the odoriferous tuft is not limited to the male sex; it exists in the females also, but the hairs are shorter and less numerous and the odour emitted is much fainter than in the males. The males have a well-defined brown spot, covered by the tuft; this is hardly distinguishable in the females. As the tuft exists in all the males of the group—which contains about a dozen of genera with more than two hundred species—as it is wanting in almost all the females, and as in *Thyridia Megisto* it is much less developed in the female sex, there can, I think, hardly be any doubt that it has been acquired as a sexual attraction by the males of the common

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\* There are two widely-separated tufts in the male of a small species of this group, resembling in size and colour *Cytopoda dichrou*, one of our *Glaucoptidæ*.

progenitor of the group, and that it has been but recently transmitted to the females of *Thyridia*.

#### Subfamily 2. SATYRINÆ.

The males of *Antirrhæa Archæa* have highly-developed odoriferous organs, and emit a strong odour; there is a most elegant mane of pale buff hairs on the under side of the front wings, and opposite to it the hind wings bear an odoriferous spot, which has caused a considerable modification of the neuration of the wing.\* A second much smaller odoriferous spot exists in the angle between the submedian and internal nervures.

In the allied genus *Pierella* no trace of odoriferous organs could be found nor any odour perceived.

#### Subfamily 4. MORPHINÆ.

The wings of the males are known to be generally provided with tufts of hairs or with spots of peculiar appearance, which probably will prove to be odoriferous organs. The only genus, the wings of which are deprived of such organs, is *Morpho*. In compensation the males of all the species of *Morpho* which I have caught (*M. Hercules*, *Epistrophis*, *Adonis*, *Cytheris*, *Menelaus*, *Achilles*) are able to protrude from the end of the abdomen a pair of hemispherical bodies covered with short hairs, which produce a very distinct odour. In the splendid *M. Adonis* and the allied *M. Cytheris* this odour is most agreeable, resembling vanilla.

#### Subfamily 5. BRASSOLINÆ.

Pencils of hairs, capable of being erected voluntarily, or spots of peculiar scales are present on the hind wings of most genera. Their position varies much, even within the limits of the same genus. In the males of various species of *Caligo*, *Dasyophthalma* and *Opsiphanes*, I found that very distinct odours were emitted by these pencils or spots, the odour being particularly strong in a species of *Dasyophthalma*.

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\* See *Butler*, Catal. Satyrid. Br. Mus. 1869, Pl. V. fig. 3. In *Butler's* figure of the mane ("plaga pectinatim cirrata") the hairs appear to be directed backward, while the contrary is the case; they are inserted along the submedian nervure and directed forward.

## Subfamily 6. ACRÆINÆ.

On crushing either sex of *Acræa Thalia*, a disgusting odour is perceived, which probably renders it unpalatable to most insectivorous animals; there appear to be no special organs for the emission of odours.

## Subfamily 7. HELICONINÆ.\*

The butterflies of this subfamily also possess a disgusting odour, and both sexes are provided with special organs for its emission. In the male they are situated between the anal valves, in the female on the dorsal side of the end of the abdomen. The odours emitted appear to be generally stronger in the female sex.†

## Subfamily 8. NYMPHALINÆ.

A. *Epicalia* group.

Unusually strong odours are emitted by the males of *Myscelia Opis* and *Epicalia Acontius*. Both of them have a large odoriferous spot on the upper side of the hind wings, and opposite to this a similar spot, covered by a mane of black hairs, is situated on the front wings of *Epicalia Acontius*. It is very remarkable that the odoriferous organs, which are so highly developed in *Epicalia Acontius* are completely wanting in *Epicalia Numilia*, and it is yet more remarkable that they closely resemble in various particulars those of *Antirrhæa Archæa*, though they were no doubt independently acquired in both species. In both these butterflies the posterior margin of the front wings and the anterior margin of the hind wings are much dilated; in both of them a mane of long hairs is inserted on the under side of the front wings, along the submedian nervure, covering an odoriferous spot (which is well developed in *Epicalia*, but most rudimentary in *Antirrhæa*), and opposite to the mane there is a large odoriferous spot on the hind wings, the central part of which fills the angle between the two subcostal nervures, extending into the three adjoining cells

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\* I have lately shown (Stettin. Entomol. Zeitung, 1877, p. 492) that the genera *Colænis* and *Dione* cannot be separated from *Heliconius* and *Eueides*.

† For a full description of the odoriferous organs of the female *Heliconinæ*, see a paper in *Zeitschrift für Wissenschaftliche Zoologie*, vol. xxx. p. 167.

of the wing. If we knew only these two species of *Nymphalinae* and *Satyrinae*, we should unhesitatingly assume that their odoriferous organs, situated on the same place, composed of the same parts, and in the same position, were inherited from common progenitors; and yet this would be a great mistake.

### B. *Ageronia* group.

In the male of *Ageronia Arethusa* a rather strong odour is emitted by two large brown spots, situated between the wings, one on the under side of the front wing, occupying the basal half of the cell between the submedian nervure and first median nervule, the other on the upper side of the hind wings. The microscopical structure of the scales and the wing-membrane of these spots differs but little from that of the rest of the wings. In *Ageronia Amphinome* and *Feronia* neither odours nor odoriferous organs could be detected.

*Didonis Biblis* is, so far as odours are concerned, the most interesting of all butterflies that I know. The male is able to emit as many as three different odours. On seizing a *Didonis* of either sex, it protrudes on the dorsal side of the abdomen, between the fourth and fifth segments, a pair of hemispherical protuberances, covered with greyish hair-like scales and producing a strong, rather disagreeable odour. The male has a second pair of similar protuberances between the fifth and sixth segments of the abdomen, covered with white hair-like scales. These white protuberances he never exposes when caught; they emit an agreeable odour, comparable to that of heliotrope, and are of so elegant an appearance that they probably serve at the same time as an ornament. A very different musk-like odour is produced by a black spot, which is situated on the under side of the front wings of the male near the base between the median and submedian nervures. This odour is very faint; it is convenient to remove the abdomen before trying to perceive it. I may add that the hind wings of the male also have a very small greyish spot near the base, which is wanting in the female.

### C. *Apatura* group.

A distinct odour issues from the tuft of black hairs which distinguishes the hind wings of the male sex of *Prepona Laertes* and several other allied species.



## Family 3. LYCÆNIDÆ.

It is well known that the males of very many species of *Thecla* have a "sexual spot" on the disc of the front wings, and that sometimes (*e. g.*, in the males of *T. Acmon*) the neuration of the wing is greatly altered by the presence of this spot. In the male of *T. Atys* an unusually strong odour is produced by this "sexual spot," and more or less distinct odours by various other species, the names of which I do not know.

## Family 4. PAPILIONIDÆ.

## Subfamily 1. PIERINÆ.

The front wings of the male *Leptalis Thermesia* have a chalky oval spot on their under side, and opposite to this there is a dark-brownish spot on the upper side of the hind wings. Both these spots emit a very strong odour, disagreeable to human noses, but probably not so to his females. A similar, though much fainter odour has been observed in the male *Leptalis Astynome* and *L. Melite*.

A very delicious perfume is produced on the upper side of the wings of the male *Daptonoura Lycimnia*. It is rather faint and often hardly distinguishable when the butterfly is caught. In this case it may easily be rendered distinct by keeping the living animal for some time with the wings closed. On the whole upper surface of the wings there are, among the ordinary scales, in the males of this species (as in many species of *Pieris*, *Hesperocharis*, *Archonias*, *Pereute*, &c.), numberless peculiarly-formed odoriferous scales or "plumules," as they were called by Bernard Deschamps. In *Daptonoura Lycimnia* these "plumules" are club-shaped and fringed with fine hairs at the end.

When a female of *Daptonoura Lycimnia* (and various other butterflies, *Callidryas*, *Anartia*, &c., behave in the same manner) is willing to admit a male, she expands her wings horizontally, lifts a little the end of the abdomen and exposes her copulating organs. Then the male is seen to hover above and to fly around her; but often, far from accepting the offer of the female, which, after a long courtship, finally surrenders herself to his wishes, he suddenly flies away without returning. What may be the cause of his thus abandoning her at the decisive moment?

The only thing which he could not perceive, whilst chasing after the female, is that part of her sexual organs which is now for the first time exhibited to him. Now, these copulating parts of the female, when protruded, emit a peculiar odour, and it is probably the individual odour of the several females which determined the decision of the male. In *Daptonoura Lycimnia* this odour is rather faint, though quite distinct. It is very different from that emitted by the wings of the male.

The male of *Daptonoura Haire* is also provided with "plumules" on the upper side of the wings, but no odour was here perceived. At the same time he has a tuft or pencil of brown hairs at the end of the abdomen, on the ventral side. This tuft is not retractile, but applied to the ventral margin of, and partially hidden between, the anal valves; it may be made to radiate in every direction and then emits a rather strong odour. This tuft of hairs exists in the female also, but it is much shorter, and I could not perceive any odour produced by it.

The males of most species of *Callidryas* have a chalky spot on the upper side of the hind wings, near the base and the anterior margin; sometimes it is covered by a mane of long hairs, and sometimes the front wings also have a similar spot opposite to that of the hind wings. I perceived a musk-like odour issuing from this spot and mane in *Callidryas Cipris*, *C. Argante*, and *C. Trite*. It is unusually strong in *Cipris*, very distinct in *Argante*, rather faint in *Trite*. In several males of this last species which I caught two years ago I could not perceive any odour, while I find it to be quite distinct in all those which I have lately examined. Are those butterflies producing a more powerful perfume in 1878 than they did in 1876, or have my olfactory organs, by continual exercise, become more acute in the meantime? According to Boisduval, the chalky spot is wanting in the male *Callidryas Eubule*, and, indeed, it may easily be overlooked through hardly differing in colour from the rest of the wing; but it exists, and is easily discovered by its opacity after denuding the wing. It emits a faint musk-like odour.

The females of *Callidryas Argante*, *Eubule*, and probably also of other species, show on either side of the protruded copulating organs a small, shining, circular spot, from which a very strong peculiar odour issues, in which some volatile acid seems to predominate.



## Subfamily 2. PAPILIONINÆ.

When special organs for emitting odours are developed in the males of this subfamily, they are placed along the anal margin of the hind wings, which is then usually recurved. It can be expanded, and the odoriferous organs exposed by moving the wings strongly in a forward direction. In some species a very strong odour is emitted by the upper side of the wings of the male without any special organs having been found (but I must add, that I have not yet compared microscopically the wings of the two sexes). This is the case with *Papilio Polydamas* and *Hyperion*. In *P. Polydamas* there appear to be two sets of males emitting equally strong, but quite different, odours. This would be analogous to the case of the two sets of differently-coloured females in some species of this genus. *P. Polydamas* is generally the most common of our *Papilios*, but in the last summer it has been rather rare, and I have examined but a small number of living males; thus, on examining a larger number, intermediate odours may be found.

In *Papilio Scamander* or *Grayi*\* the black hairs existing in both sexes on the upper side of the hind wings, are much more developed near the anal margin in the males, which emit a strong, most agreeable odour, issuing from these hairs; the females are scentless.

In the male *Papilio Protesilaus* the hairs near the anal margin of the hind wings are developed to a long black beard, which is hidden by the recurved margin of the wing, and exhales, when uncovered, a very strong, or rather disagreeable, odour. Beard and odour are wanting completely in the female sex.†

In the male *Papilio Nephalion* the pouch formed by the recurved anal margin of the hind wings is filled with an astonishing quantity of white silky down. In a male

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\* This butterfly visited in large numbers the flowers of a red *Salvia*, in the highlands of the province of Santa Catarina, near S. Bento. Some specimens agreed with *Boisduval's* description of *P. Scamander*, others with that of *Papilio Grayi*, and most of them were intermediate between the two.

† *Felder* (Species Lepidop. 1864, p. 57) states that among a large number of specimens of *Papilio Protesilaus*, *Agessilaus* and *Telesilaus* he could not find any female. In 1876 *Pap. Protesilaus* (var. *Telesilaus*) was extremely common, both on the river Itajahy and on the highlands of Curitibaños, and I think I have caught more than a hundred specimens, among which there were but two females.

which I lately caught I perceived a faint agreeable odour on opening the pouch.

#### Family 5. HESPERIDÆ.

The *Hesperidæ* agree with moths in many particulars, which are not to be found in any other butterflies. Thus, as in many moths, the tibiæ of the hind legs are provided in the males of various species with a large pencil of long hairs. It can be hidden in a furrow on the ventral side of the body, between thorax and abdomen. In *Plesioneura Eligius*, and in a species of *Achlyodes*, I perceived a very faint odour issuing from the pencils when they were expanding.

#### MOTHS.

In butterflies, as we have seen, the odoriferous organs of the males in most cases are developed on the wings; in but few genera (*Danaüs*, *Lycorea*, *Ituna*, *Morpho*, *Biblis*) they were found on the abdomen, and, in some *Hesperidæ*, on the hind legs. With moths the case appears to be very different. Though not wanting on the wings, these organs seem to occupy much more frequently the abdomen or legs.

A musk-like odour is known to be produced by several male sphinx moths; I have observed it in *Macrosilia Anteus* and two other species. It is emitted by two pencils of pale hairs on the ventral side of the abdomen, which can be hidden in longitudinal grooves on the first two abdominal segments. To see them in the living male he must be held with the ventral side turned upward, so that he can freely move his wings. As soon as he begins to flutter, the pencils will expand, and when the wings cease to move, they will be laid down again into their grooves.

The males of the *Glaucopidæ* are provided with two long hollow retractile filaments, generally beset with hairs, which they can protrude from the end of the abdomen, on the ventral side; sometimes they exceed the body in length, and are then rolled into an elegant helix. They emit, in most cases, a distinct odour, which is very strong in some species (*e. g.*, *Belemnia inaurata*). Two similar filaments, producing a strong odour, exist in the male of a *Cryptolechia*. I have seen retractile pencils, tufts of hairs, or hairy protuberances, some of them emitting distinct

odours, at the end of the abdomen of various other male moths, of which I do not know the names.

Pencils or tufts of hairs appear to be of rather frequent occurrence on the legs of male moths, *e. g.*, among the *Erebidæ* and *Geometridæ*, and in two or three cases odours were observed to issue from them.

In one of our largest *Erebidæ* the tibiae of the hind legs are much dilated in the male, and densely covered with peculiar hairs, capable of being voluntarily erected; they emit a faint but distinct odour.

As I know as yet but a very insignificant part of our moths, a vast number of other odoriferous contrivances may be expected to be found among the extremely numerous species of these insects.

#### *Sounds made by Butterflies.\**

I know here four species of *Ageronia* (*Feronia*, *Fornax*, *Amphinome* and *Arethusa*), all of which are rather common in certain localities where their food-plants (*Dalshampia*) abound. I have frequently heard the noise made by them and can fully confirm Mr. Darwin's statement, that this noise is produced, almost exclusively, when two are chasing each other. Sometimes a short, clicking noise is made, when an *Ageronia* is caught in the net. On October 30th, 1876, at the mouth of the Rio Trombudo, a tributary of the Itajahy, I saw two butterflies chasing each other, which produced a loud clicking noise, and settled from time to time in the manner of *Ageronia*, with the wings expanded horizontally, on dry stems of *Tagnara* (bamboo). I, of course, imagined them to be some species of *Ageronia*, but after having succeeded in catching one of them, found that it was *Eunica Margarita*. I may observe that the venation of the wings of that butterfly bears a rather close resemblance to that of *Ageronia*, so that, indeed, it may be more nearly allied to that genus than is generally assumed.

On February 21st, 1877, at the foot of the Serra de Itajahy, I heard a noise resembling that of *Ageronia*, but

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\* The following notes are supplementary to a paper by Mr. Meldola, entitled "Entomological Notes bearing on Evolution," in Ann. and Mag. of Nat. Hist., Feb. 1878.

rather louder, produced by two small brown butterflies, which seemed to be *Euptychia*, but which I did not succeed in catching.

It has been suggested that the production of sound by *Ageronia* is connected with the existence of a small membranous sac at the base of the front wings, which in the living insect is filled with air when the costal nervure is compressed. But this sac also exists in several other butterflies, which seem to be incapable of producing sounds, e. g., *Pyrrhogyra Edocla* and *Callicore Eluina*. If I remember rightly, in *Eunica Margarita* the sac is wanting.

#### *Insects distinguishing Colours.*

In flowers with changing colours, most of the visiting insects perfectly distinguish the first honey-filled flowers, as I have ascertained by a long series of observations on some species of *Lantana*. In some species the difference in colour between the fresh flowers and the older ones is but very trifling, a small yellow circle surrounding the entrance to the tube of the corolla during the first day and disappearing afterwards.

A specimen of *Victorina Frayja* was lately observed settling on the flower of a rose-tree painted on a wall; the painter was much pleased by seeing his skill thus acknowledged by that butterfly.

#### *Mimicry.*

In some years, as I stated in 1871, *Mechanitis Lysimnia* is here hardly more common than the imitating *Leptalis Astynome*; but in most years *M. Lysimnia* is extremely abundant and *L. Astynome* rather rare.

When I descended in a canoe the western branch of the Itajahy (December 16th, 1876), small white butterflies were very common on the banks of the river: all appeared to be of the same species. I caught about a dozen, and on examining them at home found them to be *Leptalis Nehemia*, which so wonderfully mimics a *Pieris*, that even Boisduval was deceived and described it as *Pieris Nehemia*. Now, in his case, the model must have been either by far more rare than the copy, or entirely wanting.

On the Itajahy we have three species of *Euclides*, viz., *E. Pavana*, *Isabella* and *Aciphera*; all of them are rare, and *E. Pavana* extremely so. This last species closely resembles *Acræa Thalia*; *E. Isabella* resembles *Mechanitis Lysimnia* and *Heliconius Eucrate*, while *E. Aciphera*

mimics *Colenis Julia*. I, therefore, formerly thought that the three rare species of *Eueides* mimicked the three common species of *Acræa*, *Mechanitis* and *Colenis*. Afterwards, after finding that the several species of *Eueides* possess a very strong and repugnant odour, I had become somewhat doubtful, and at São Bento I found that *E. Aciphera* was extremely common, so common, indeed, that repeatedly I caught as many as eight specimens in the net at once, whereas *C. Julia* was so rare that I have only seen two or three specimens altogether. Thus, judging by their relative abundance, an observer on the Itajahy might consider *E. Aciphera* to be a mimic of *C. Julia*, while an observer at São Bento might take *C. Julia* to be a mimic of *E. Aciphera*.

#### *Correlation of Habit with Protective Resemblance.*

Any number of cases might be given. The case which has most struck me is that of the caterpillar of a small moth belonging to the curious Coehliopod group. This caterpillar has long lateral processes, overlapping each other, and imitates in a truly wonderful manner a dry leaflet of the food plant *Cussia multijuga* with the apical half gnawed off. Now, when gliding along slowly and smoothly, as Coehliopod larvæ are accustomed to do, it has the strange habit of making curious waving movements from side to side, just as a dry leaf moved by the wind. A dry leaf marching in a straightforward manner would be a strange thing, and might rouse the attention of some intelligent bird, whilst it would not look at a leaf moved by the wind.

Another curious instance is that of the caterpillar of our Brazilian "leaf-butterfly" (*Siderone strigosus*); when very young it feeds on the tips of the lanceolate leaves of a *Casearia*, sparing the mid rib, on which it rests. This habit of resting on the denuded ribs of leaves is common to various young caterpillars (*Protogonius*, *Adelpha*, *Gynæsia*), and they are thus very well protected. When somewhat larger, the caterpillars of *Siderone strigosus* (and of *Siderone Ida*, which live on the same plant) bite small pieces from the leaf, fastening them to the mid rib, with their margins rolled in, and the brown colour which these bits of leaf soon assume excellently conceal the small brown caterpillar which sits between them; at last the full-grown larva itself perfectly imitates a rolled dry leaf.